

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the applications.

LISTING OF CLAIMS:

1. (currently amended) A piezoelectric ceramic composition comprising:

a phase comprising, as a main component, lead zirconate titanate having a perovskite structure; and

an Al-containing phase,

wherein:

said main component is represented by a composition formula of $\text{Pb}_\alpha[(\text{Mn}_{1/3}\text{Nb}_{2/3})_x\text{Ti}_y\text{Zr}_z]\text{O}_3$ (wherein $0.97 \leq \alpha \leq 1.01$ ~~≤ 1.01~~ < 1.00 , $0.04 \leq x \leq 0.16$, $0.48 \leq y \leq 0.58$, $0.32 \leq z \leq 0.41$) and

said piezoelectric ceramic composition comprises Al_2O_3 in an amount of 0.15 to 15.0 wt%.

Claims 2 and 3 (cancelled).

4. (original) The piezoelectric ceramic composition according to claim 1, wherein:

said Al-containing phase comprises Al_2O_3 .

5. (original) The piezoelectric ceramic composition according to claim 1, wherein:

said piezoelectric ceramic composition is composed of a sintered body comprising grains and grain boundaries exist between said grains; and

Al_2O_3 is contained in said grains and is precipitated in said grain boundaries.

Claim 6 (cancelled).

7. (original) The piezoelectric ceramic composition according to claim 1, wherein:

$|\Delta F_0|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof, before and after application of a thermal shock, is 0.10% or less; and

the three-point flexural strength σ_{b3} thereof is 160 N/mm^2 or more.

8. (currently amended) A piezoelectric ceramic composition comprising:

a main component represented by the formula of $\text{Pb}_\alpha[(\text{Mn}_{1/3}\text{Nb}_{2/3})_x\text{Ti}_y\text{Zr}_z]\text{O}_3$, wherein α , x , y and z fall within

the ranges of $0.97 \leq \alpha \leq 1.01$, $0.04 \leq x \leq 0.16$, $0.48 \leq y \leq 0.58$ and $0.32 \leq z \leq 0.41$, respectively; and

as an additive, at least one element selected from the group consisting of ~~Ga, In, Ta and Se~~ Ga and In in an amount of 0.01 to 15.0 wt% in terms of an oxide of each element.

9. (original) The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition has α , x , y and z of said main component falling within the range of $0.98 \leq \alpha < 1.00$, $0.06 \leq x \leq 0.14$, $0.49 \leq y \leq 0.57$ and $0.33 \leq z \leq 0.40$, respectively.

10. (original) The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition has α , x , y and z of said main component falling within the range of $0.99 \leq \alpha < 1.00$, $0.07 \leq x \leq 0.11$, $0.50 \leq y \leq 0.55$ and $0.34 \leq z \leq 0.39$, respectively.

11. (currently amended) The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition further comprises Al as an ~~said~~ additive in an amount of 0.05 to 5.0 wt% in terms of Al_2O_3 .

12. (currently amended) The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition further comprises Al as an ~~said~~ additive in an amount of 0.15 to 1.5 wt% in terms of Al_2O_3 .

13. (original) The piezoelectric ceramic composition according to claim 8, wherein:

said piezoelectric ceramic composition comprises Si in an amount of 0.005 to 0.15 wt% in terms of SiO_2 .

14. (original) The piezoelectric ceramic composition according to claim 8, wherein:

the electric property Q_{\max} ($Q_{\max} = \tan\theta$: θ is a phase angle) thereof is 30 or more;

$|\Delta k_{15}|$ which is the absolute value of the rate of change in electromechanical coupling factor k_{15} thereof, before and after application of a thermal shock, is 4% or less;

$|\Delta F_0 (-40^\circ\text{C})|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof at -40°C , with reference to 20°C , is 0.4% or less; and

$|\Delta F_0 (85^\circ\text{C})|$ which is the absolute value of the rate of change in oscillation frequency F_0 thereof at 85°C , with reference to 20°C , is 0.4% or less.

15. (currently amended) A piezoelectric ceramic composition comprising a sintered body comprising; as a main component, a perovskite compound having mainly Pb, Zr, Ti, Mn and Nb; and as an additive, at least one element selected from the group consisting of ~~Ga, In, Ta and Se~~ Ga and In, wherein:

the electric property Q_{\max} ($Q_{\max} = \tan\theta$: θ is a phase angle) thereof is 100 or more;

$|\Delta k_{15}|$ which is the absolute value of the rate of change in electromechanical coupling factor k_{15} thereof, before and after application of a thermal shock, is 2% or less;

$|\Delta F_0 (-40^\circ\text{C})|$ which is the absolute value of the rate of change in oscillation frequency F_0 at -40°C thereof, with reference to 20°C , is 0.2% or less; and

$|\Delta F_0 (85^\circ\text{C})|$ which is the absolute value of the rate of change in oscillation frequency F_0 at 85°C thereof, with reference to 20°C , is 0.2% or less.

16. (currently amended) The piezoelectric ceramic composition according to claim 15, wherein:

said sintered body further comprises Al_2O_3 .

17. (original) The piezoelectric ceramic composition according to claim 15, wherein:

said sintered body comprises a main component represented by the formula of $\text{Pb}_\alpha[(\text{Mn}_{1/3}\text{Nb}_{2/3})_x\text{Ti}_y\text{Zr}_z]\text{O}_3$, wherein α , x , y and z fall within the range of $0.99 \leq \alpha < 1.00$, $0.07 \leq x \leq 0.14$, $0.50 \leq y \leq 0.55$ and $0.34 \leq z \leq 0.39$, respectively.

18. (previously presented) The piezoelectric ceramic composition according to claim 1, wherein:

said piezoelectric ceramic composition comprises Al_2O_3 in an amount of 0.6 to 15.0 wt%.

19. (previously presented) The piezoelectric ceramic composition according to claim 1, wherein:

said piezoelectric ceramic composition comprises Al_2O_3
in an amount of 0.6 to 5.0 wt%.

20. (previously presented) The piezoelectric ceramic
composition according to claim 1, wherein:

said piezoelectric ceramic composition comprises Al_2O_3
in an amount of 0.6 to 1.5 wt%.